

Introduction to the ISD Measurement Program

July 25, 2005

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Software Process Improvement (SPI) Project

Objectives

- **Purpose - Provide an overview of the ISD measurement program.**
- **Objectives -- After this session you should know**
 - Why organizational measurement?
 - What does a project have to do?
 - What ISD Measurement Team will do with data collected
 - What is produced for software teams & ISD
- **Note:**
 - **“Measurement and Analysis for ISD Software Projects” Software Engineering Discussion**

Agenda

- **Setting the stage: why measure?**
- **ISD Measurement Program**
- **Good advice for organizational measurement**
- **Summary**

Why Measure?

■ Managing projects

- Compare actual results with plans and expectations

■ Understanding process

- Create models of typical projects; for example what percentage of effort is needed for test?

■ Guiding Improvement

- Introduce new process or technology and assess impact on project results

Example: Planning models

Source: Flight Dynamics Division

Effort & Schedule model

Milestone	% of schedule	% of staff effort
Through SRR	12	6
Through PDR	20	14
Through CDR	35	30
Through TRR	65	70
End of acceptance test	100	100

Defect model (4-2-1 rule)

- Expected defects by phase
 - 4 per KSLOC in implementation
 - 2 per KSLOC in system test
 - 1 per KSLOC in acceptance test

Example: Guiding Improvement

Source: Flight Dynamics Division

Setting Expectations for New Methodology

	SAMPLE MEASURES	SAMPLE BASELINE	SAMPLE EXPECTATION
PROCESS	<ul style="list-style-type: none"> • Effort distribution • Change profile 	Design 23% Code 21% Test 30% Other 26%	Increased design %
COST	<ul style="list-style-type: none"> • Cost per LOC • Level of rework • Impact of spec mods 	Historically, 26 LOC per day	No degradation of current level
RELIABILITY	<ul style="list-style-type: none"> • Error rate • Error distribution • Error source 	Historically, 7 errors /KSLOC	GOAL: Lower error rate



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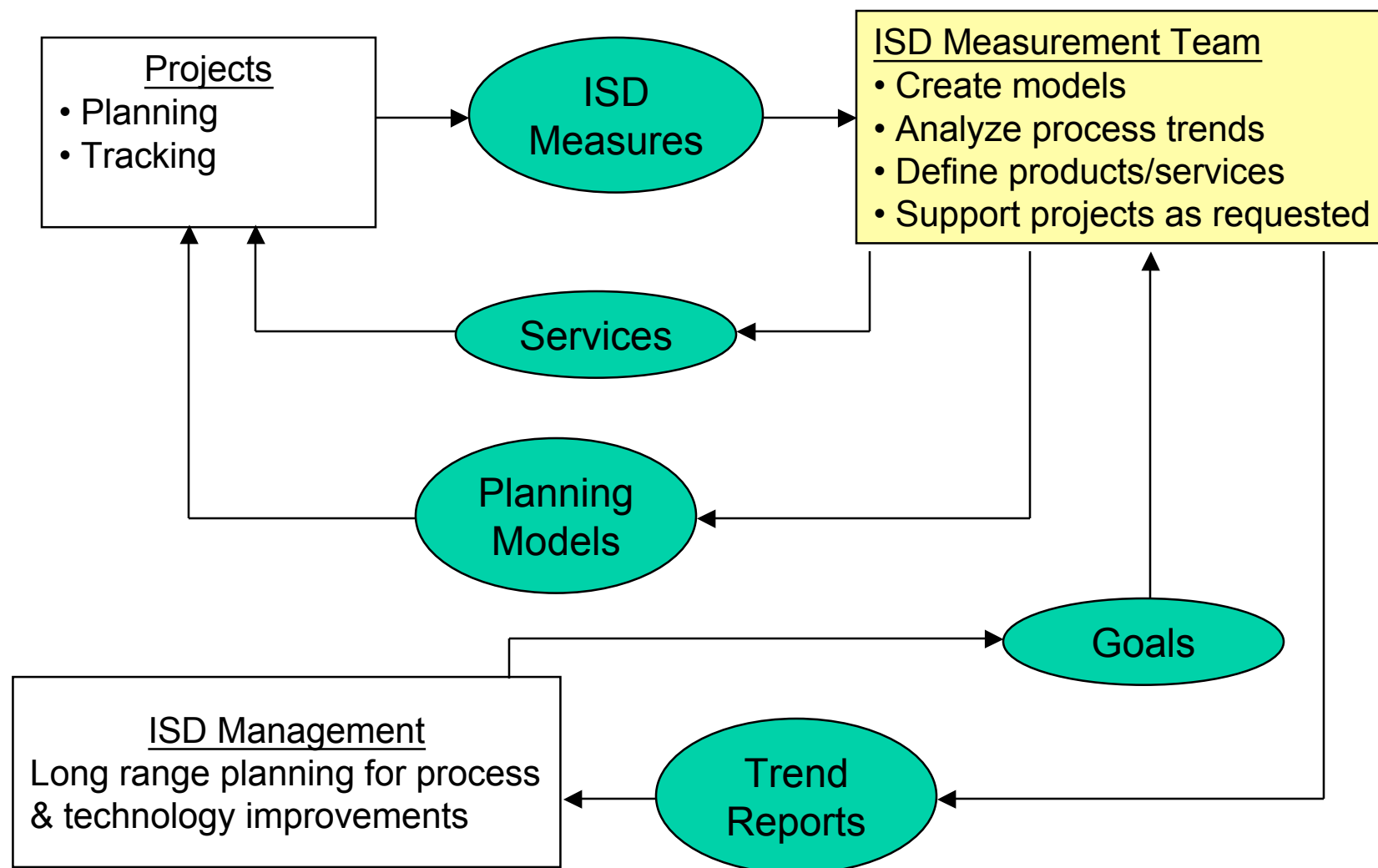
Organizational Measurement at a Glance

1. Set goals & define strategy
2. Create models & define data with respect to goals & strategy
3. **Collect & store data from software teams**
4. Analyze data
5. Deliver results to users (software teams, ISD management)
 - Planning models to software teams
 - Trend reports to ISD management
 - Services offered to SW teams, management
6. Repeat as needed.

1. Setting Goals & Strategies

- **Initial Goal:**
 - Establish a measurement program and create an **initial measurement baseline** to support
 - ISD software teams in managing their projects
 - ISD management team in applying SPI
- **Strategies (listed as “goals” ISD Measurement Program Implementation Plan)**
 1. Build software models for use by future projects
 2. Track performance trends
 3. Assess impact of SPI on ISD project performance
 4. Provide measurement support to projects
 5. Provide support to the ISD and its projects in meeting NASA measurement requirements (e.g., NPR 7150.2)

ISD Measurement Program Organization



2. Create Models and define data (1 of 2)

■ Considerations

- Need data to support analysis with respect to goals
- Need to minimize overhead to projects
 - Provide easy collection format & procedures
 - Use data projects need anyway

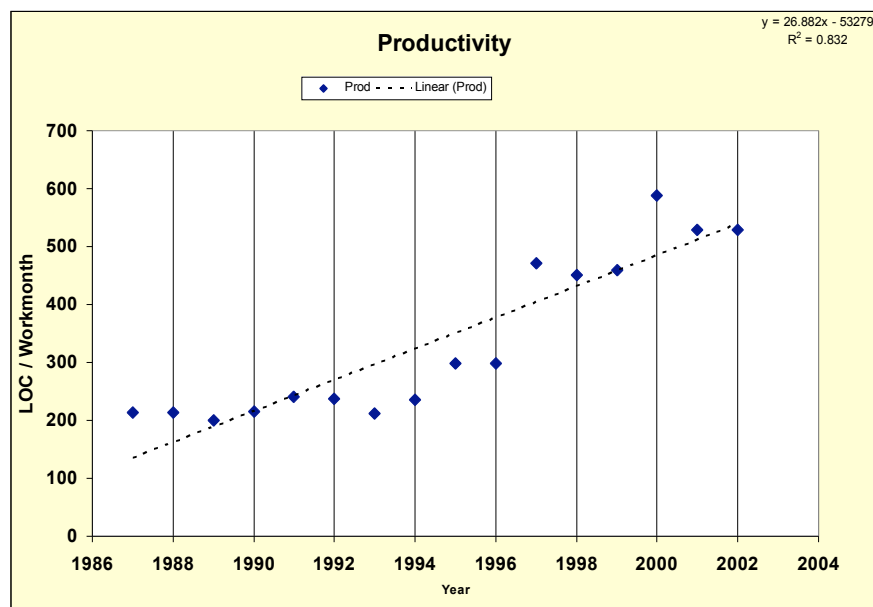
■ With minimal data, we can produce a lot of useful models

2. Create Models and define data (1 of 2)

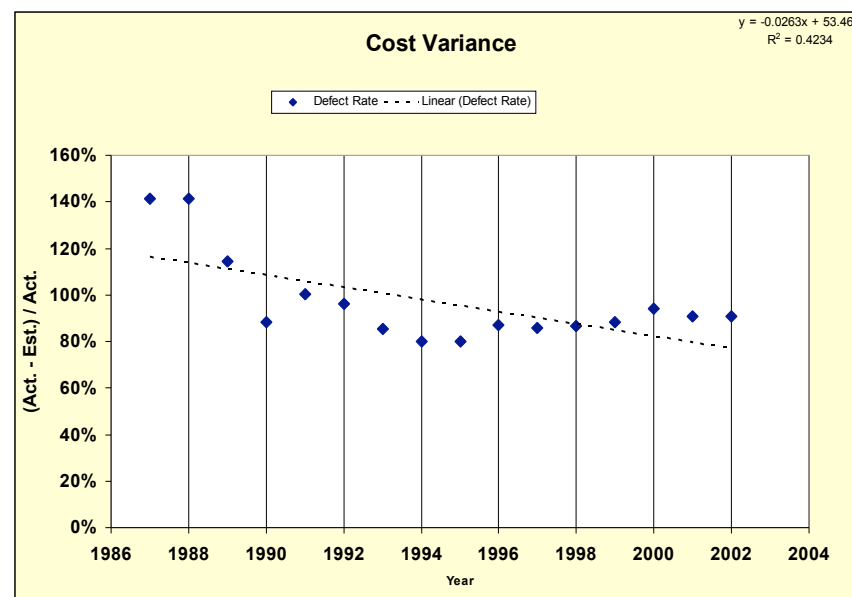
Models defined in ISD Measurement Plan

1. Total effort estimate
2. Effort estimate by phase
3. Total schedule estimate
4. Schedule estimate by phase
5. Effort (remaining) prediction
6. Schedule tracking and prediction
7. Requirements volatility by phase
8. Defect Profile by phase
9. Productivity trend
10. Management performance trend
11. Impact of requirements volatility
12. Productivity by CMMI or internal assessment level
13. Defects by CMMI or internal assessment level
14. Effects of technology or process

Example: Measuring trends (ISD Plan Goal 2)



9. Productivity trend



10. Management performance trend

Use of data

Future projects: better planning/cost estimation
ISD management: view into **organization's** performance

Example: Assessing Impact of SPI (ISD Plan Goal 3)

- **CMMI assessments: more than a digit**
 - Can look at trends in individual practices
 - Assessments produce stoplight charts, are they turning greener over time?
- **Quick look assessment: a short list of key items,**
 - e.g., does SMP exist, is CM being done, is there a test plan,...
 - Based on short interviews with software teams
 - Again, are stoplight charts turning greener?
- **Correlate these trends with productivity, etc.**

3. Collect & Store Data From Software Teams: Who, What, Where & When

- **Who provides data?**
 - All mission software projects
 - All other ISD projects larger than 5 staff years
- **What do software teams provide?**
 - Data collected via Excel spreadsheet
- **Where is data stored?**
 - Data is stored in cross-project database and used to build models we've defined
- **When is data collected?**
 - **NOW!!!!**

3. Collect & Store Data from Software teams: Spreadsheet details

■ 3 worksheets

- **Project characteristics** -- key characteristics such as COTS & languages used collected at start; size data collected at end
- **Milestone data** -- high-level data typically reported at milestones
- **“Notes for Analysis of Measures”** -- provide notes on spreadsheet data items to ISD measurement team. Especially changes, e.g., of estimate, COTS product used,...

■ Available on tools page

- (<http://software.gsfc.nasa.gov/tools.cfm>)

Project Characteristics Spreadsheet

Project Name	
Contact Name	
Contact e-mail	
Software Type	

CSCI Name	Class	Language(s)	COTS product(s)	Platform	Size	Units

Color Coding Key

Yellow fill = end of project
White fill = project start

Milestone Data Spreadsheet

Project Acronym
Current Date

Event:	Start	SRR	PDR	CDR	Start Test	End Test	Maint.
Basis of Estimate Provided (Y/N)							

Estimated and Actual Milestone Dates

System Requirements Review							
Preliminary Design Review							
Critical Design Review							
Start of System Testing							
Acceptance Test End							
Turnover to Maintenance							

Progress points (from point counting)

Actual at milestone							
Estimated at completion							

Effort (expressed as FTEs)

Actual at milestone							
Estimated at completion							

Requirements Data

Number of requirements							
Number of TBDs							
Cumulative changed requirements							

Cumulative Defects

critical defects found							
moderate defects found							
minor defects found							

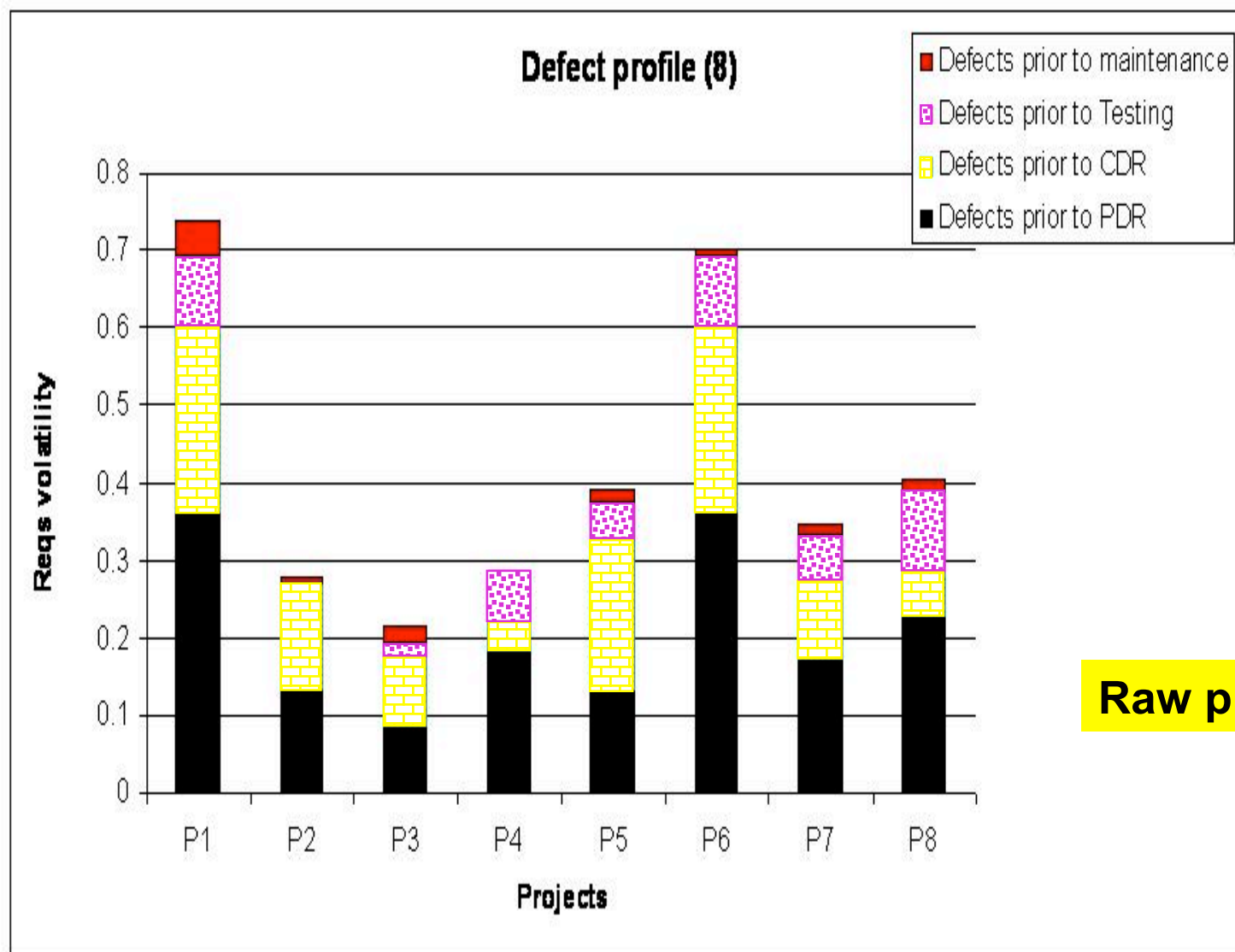
Color Coding Key

Yellow fill = actual values
White fill = estimates

4. Analyze Data

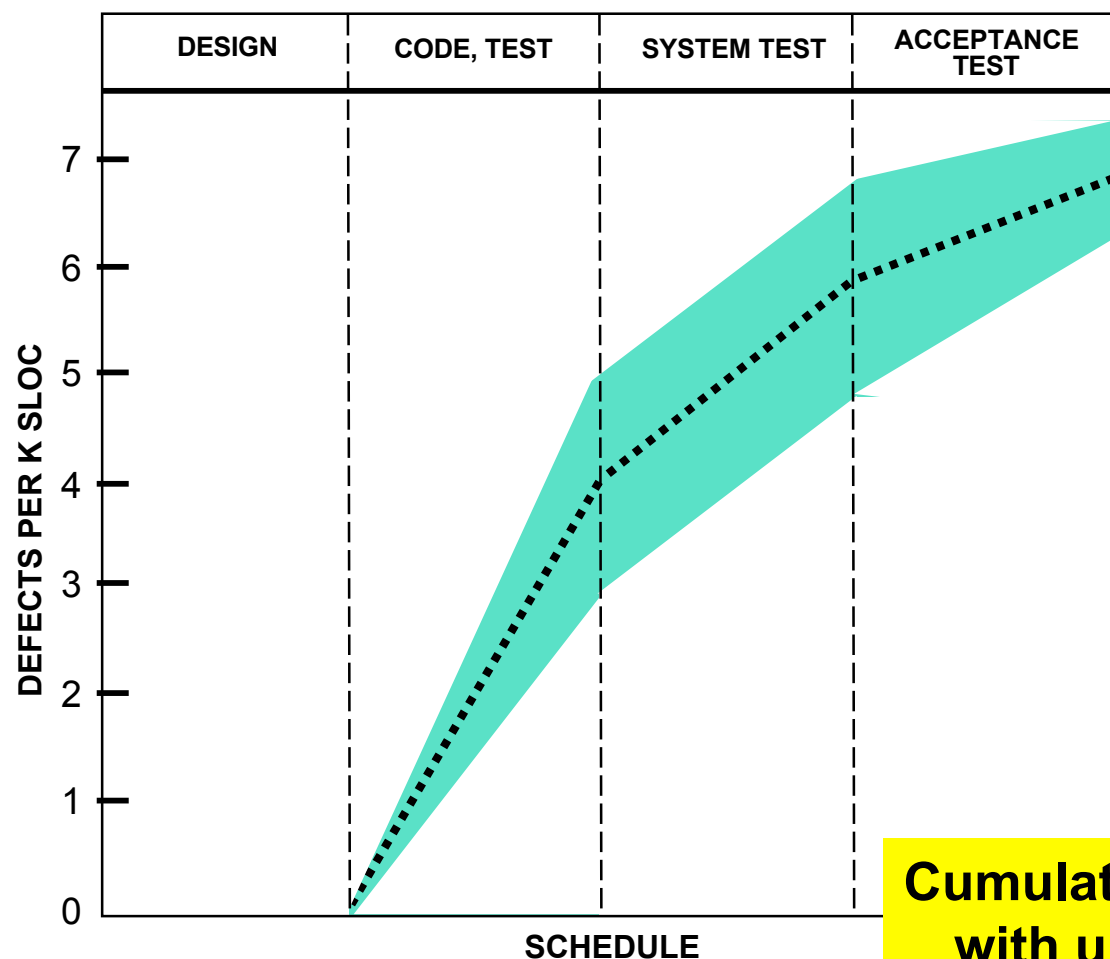
- **Select projects that are representative**
 - **Projects are not uniform, but explainable extreme variations need to be removed**
 - E.g., COBE mid-project redesign
 - **How these outliers differ may be interesting**
 - **Talk to experienced practitioners!**
- **Build planning models**
 - **Average data across projects**
 - **Provide uncertainty bands**
- **Look at trends in key measures**

Analyzing Projects: Defect Profile Example



Raw project data

Analyzing Projects: Defect Profile Example



Deviation: Actual change rates are above model upper bounds

Possible Causes:

- a) Rapidly changing requirements
- b) Inexperienced team
- c) More thorough testing (high quality)
- d) Erroneous specifications

Deviation: Actual change rates fall below model bounds

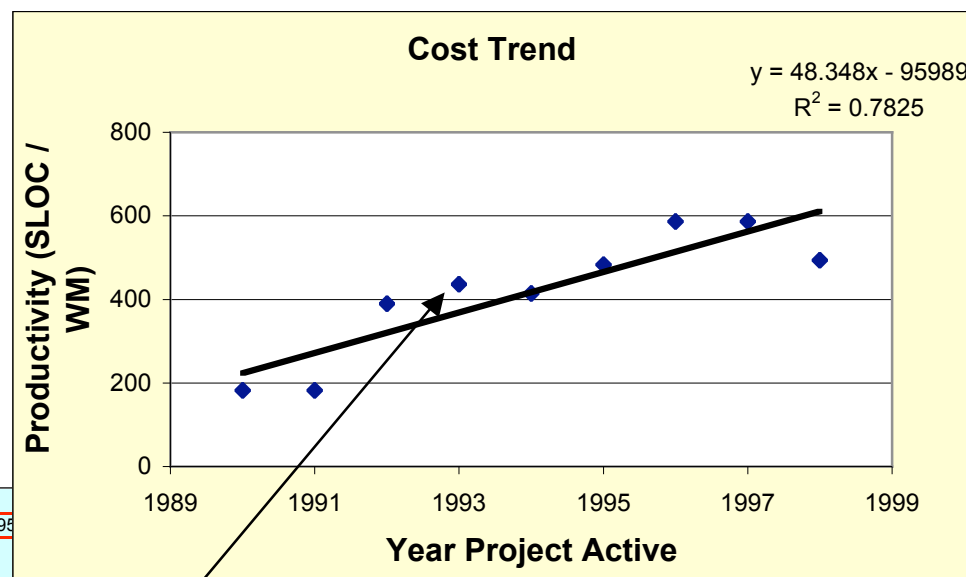
Possible Causes:

- a) Stable requirements
- b) Complete design
- c) Inadequate testing

**Cumulative defect model
with uncertainty bands**

Modeling Trends: Productivity Example

- Uses data for completed projects
- Each project that is active in a particular year is included in the year's average
- As projects reach completion, their data is added to the analysis (adding information to preceding years)
- Same analysis technique is used for other performance parameters



				1990	1991	1992	1993	1994	1995
		Size / Cost							
WINDPOL	Feb-90	Aug-92	257	257	257	257			
SAMPEX /	Mar-90	Nov-91	60	60	60				
POWITS	Mar-90	May-92	229	229	229				
GSS	Mar-92	Mar-97	172			172	172	172	172
TOMSTEL	Apr-92	Jan-94	247			247	247		
FASTELS	Aug-92	Dec-93	368			368	368		
FASTAGS	Aug-92	Jul-94	367			367	367		
SOHOTEL	Sep-92	May-94	855			855	855	855	
SOHOAGE	Oct-92	May-95	624			624	624	624	
TOMSEP	Jan-93	Jun-94	408			408	408		
SWASXTL	Apr-93	Sep-94	263			263	263		
SWASAGS	Jun-93	May-95	620			620	620		
EOSTGSS	Mar-94	Sep-98	345				345	345	345
ACE ADS	Oct-94	Oct-97	242				242	242	242
TRMM	Mar-95	Sep-97	733				733	733	733
GEODE	Oct-95	Sep-98	643				643	643	643
GMOD	Dec-95	Nov-97	150					150	150
TDU	Feb-96	Jan-97	877					877	877
ATTTFEP	Mar-96	Feb-97	982					982	982
ARS	Jun-96	Mar-97	1135					1135	1135
Average				182	182	390	436	414	483
								587	587
									494

Project active multiple years
(1992, 1993 & 1994)

Data averaged for
a single year (1993)

5. Deliver Results to End Users (Software teams, ISD Management)

- Results for **projects** available via Web site
 - <http://software.gsfc.nasa.gov/MeasProj.htm>
 - Planning models created by analysis step will be deployed via this site
 - “Help desk” support for these products

- Results for **organization**
 - Trends in productivity, quality, and predictability
 - Assessment of SPI impact

6. Repeat as necessary (1 of 2)

- **Step 1 next set of goals -- e.g.,**
 - Win more proposals
 - Happy customers and users
 - Predictable projects with less reliance on heroics
- **Step 1: next set of strategies, e.g.,**
 - Invest in reuse technology
 - Improve cost estimation/re-estimation techniques
 - Improve monitoring of and control over requirements changes

6. Repeat as necessary (2 of 2)

- **Step 2: measuring reuse technology**
 - **Add measures for proportion of artifacts that are new, modified, or reused verbatim**
 - Code, requirements, test procedures,...
 - **Modeling impact of change**
 - Has proportion of verbatim reuse increased?
 - Has productivity increased?
 - Have projects become shorter?
- **etc.**

Agenda

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Advice for organizational measurement programs

- **Start with very small set of very basic measures**
 - Add or refine measures in future iterations as you gain insight
- **Tie measurement to organization's strategic planning**
 - To assess how well plans are working
- **Focus on analysis**
 - If data isn't analyzed, don't collect it
- **Streamline collect/store/analyze/report cycle**

Summary

- **ISD is about to start its first iteration of data collection, storage and analysis steps**
 - We have done goal setting and model definition steps
- **Purpose of program is to serve ISD projects and ISD improvement goals**
- **For more information**
 - <http://software.gsfc.nasa.gov/MeasISD.cfm>
 - **Contact Mike Stark via e-mail:**
 - michael.e.stark@nasa.gov

Questions?

July 25, 2005 – Using the website <http://software.gsfc.nasa.gov/>

Find tools

Locate training and experts

Use approved process assets

See Engineering process group (EPG) Contacts

Get measurement info

See lessons learned

The screenshot shows the main page of the GSFC Software Development Process Improvement website. It features a navigation bar with links: + GSFC SW IMPROVEMENT, + PROCESS ASSETS LIBRARY, + TRAINING, + TOOLS, + MEASURES, and + LESSONS LEARNED. Below the navigation bar, there are sections for 'Welcome', 'News and Upcoming Events', and 'General Information'. The website is displayed in a Microsoft Internet Explorer browser window.

Use search function to find assets

Click asset name to get asset

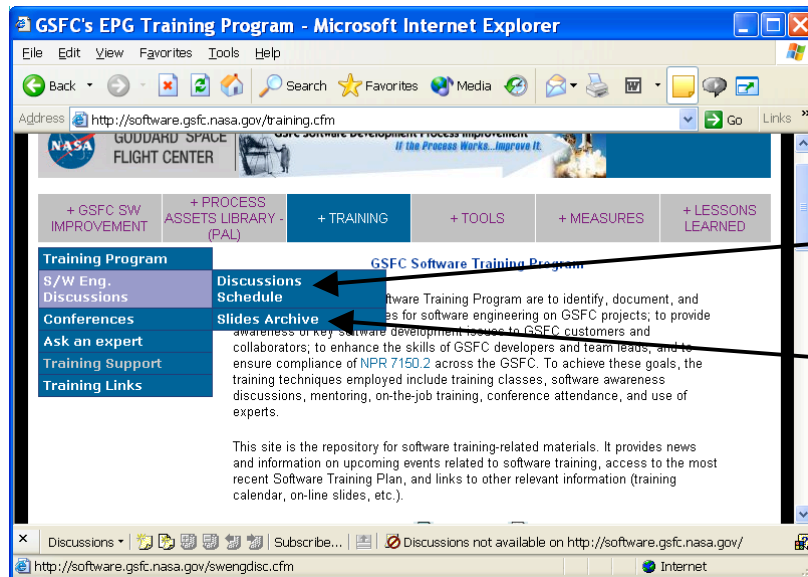
Click "?" to get feedback form

Click icons for desired files

The screenshot shows the 'Process Assets Approved' page in a Microsoft Internet Explorer browser window. It displays a table of assets with columns: Asset Number, Document Number, Title, Owner, Asset Type, Status (More Info), MS Office, and PDF. The table lists several assets, including 'ISD Software Policies', 'ISD Project Planning Process', 'ISD Software Project Estimation', 'Wide band Design Procedure', and 'ISD Software Life Cycle'. Annotations point to the search function, the asset name, the feedback form icon, and the file icons.

Asset Number	Document Number	Title	Owner	Asset Type	Status (More Info)	MS Office	PDF
1.0.0.1	580-PC-002	ISD Software Policies	?	580	Policy	CCB approved	
1.2	580-PC-004-01	ISD Project Planning Process	?	580	Process	CCB approved	
1.2.1	580-SP-026-01	ISD Software Project Estimation	?	580	Guideline	CCB approved	
1.2.1.2	580-PR-016-01	Wide band Design Procedure	?	580	Procedure	CCB approved	
1.2.2.1.1		ISD Software Life Cycle	?	582	Guideline	CCB approved	

July 25, 2005 – Accessing Presentation Slides From the Website



For SW Engineering Discussions ...
Click “Training” and highlight
“*S/W Eng. Discussions*”

Access SW Engineering Discussion schedule:
(<http://software.gsfc.nasa.gov/swengdisc.cfm>)

Access slides from past SW Engineering Discussions:
(<http://software.gsfc.nasa.gov/swengdisc.cfm>)

For Other On-Line Slides...
Click “Training” and highlight
“*Training Program*”

Access slides from other useful presentations

